

1   **CLAIM LISTING**

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3   Please amend claims 1, 6, 16, and 25 as follows:

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5       1.    (Currently amended) A method of snapshot operation for a data storage  
6   system with a first host that communicates with a cache memory, a source Virtual  
7   Logical Unit Number (VLUN) containing source data and a target VLUN, preserving first  
8   snapshot data of the source data at an instant in time and second snapshot data of the  
9   source data at a later instant in time, wherein the first and second snapshots persist  
10   concurrently, comprising:

11           generating first metadata to locate the first snapshot data and to indicate when a  
12   data element of the first snapshot data is in the target VLUN; and

13           generating second metadata to locate the second snapshot data and to indicate  
14   when a data element of the second snapshot data is in the target VLUN; wherein the  
15   first and second metadata locate an original data element of the first snapshot data and  
16   of the second snapshot data at the same address in of the target VLUN.

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18       2.    (Previously presented) The method of claim 1, wherein generating the first  
19   metadata includes generating a first log file pointer to locate the original data element in  
20   the target VLUN.

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22       3.    (Previously presented) The method of claim 2, wherein generating the first  
23   metadata includes changing a first bitmap to indicate the original data element has  
24   migrated to the target VLUN.

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26       4.    (Previously presented) The method of claim 1, wherein generating the  
27   second metadata includes generating a second log file pointer to locate the original data  
28   element in the target VLUN.

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1       5. (Previously presented) The method of claim 4, wherein generating the  
2 second metadata includes changing a second bitmap to indicate has migrated to the  
3 target VLUN.

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5       6. (Currently amended) A snapshot system for a data storage system  
6 including a first host that communicates with a cache memory, a source Virtual Logical  
7 Unit Number (VLUN), a target VLUN, and metadata, comprising:

8           a source VLUN for active data;

9           a target VLUN to store migrated snapshot data;

10           first metadata to indicate when and to locate where the first snapshot of the  
11 active data is in the target VLUN; and

12           second metadata to indicate when and to locate where second snapshot data of  
13 the active data is in the target VLUN wherein the first metadata and the second  
14 metadata indicate and locate a data element common to the first and second snapshot  
15 data in the target VLUN, wherein the snapshot system preserves the active data of the  
16 first snapshot while taking the second snapshot.

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18       7. (Original) The snapshot system of claim 6, wherein the first metadata  
19 includes a first log file pointer to locate the first snapshot data in the target VLUN and  
20 the second metadata includes a second log file pointer to locate the second snapshot  
21 data in the target VLUN.

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23       8. (Original) The snapshot system of claim 6, wherein the first metadata  
24 includes a first bitmap to indicate when the first snapshot data has migrated to the target  
25 VLUN and a first log file to locate the first snapshot data in the target VLUN, and the  
26 second metadata includes a second bitmap to indicate when the second snapshot data  
27 has migrated to the target VLUN and a second log file to locate the second snapshot  
28 data in the target VLUN.

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1           9. (Previously presented) The snapshot system of claim 6, wherein a first  
2 bitmap and a second bitmap indicate that the first snapshot data and the second  
3 snapshot data have migrated to the target VLUN.

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5           10. (Previously presented) The snapshot system of claim 6, wherein a first  
6 log file and a second log file locate the first snapshot data and the second snapshot  
7 data that have migrated to the target VLUN.

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9           11. (Previously presented) The snapshot system of claim 6, wherein the first  
10 metadata and the second metadata indicate some of the first and second snapshot data  
11 remain in the source VLUN.

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13           12. (Original) The snapshot system of claim 6, wherein the first metadata  
14 indicates that the original data of the first snapshot is in the target VLUN and the second  
15 metadata indicates that the original data of the second snapshot is in the source VLUN.

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17           13. (Previously presented) The snapshot system of claim 6, wherein a first  
18 log file and a second log file each include a pointer identifying the address of the  
19 common data element in the target VLUN.

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21           14. (Previously presented) A method of destaging data of one or more  
22 snapshots to maintain data consistency of original data between a cache memory and a  
23 target Virtual Logical Unit Number (VLUN) of a data storage system, comprising:  
24           reading bitmaps for all of the snapshots into a first host memory;  
25           reading log files for all of the snapshots into the first host memory;  
26           searching the bitmaps to identify snapshots that require the original data to be  
destaged;

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destaging the original data to an available location in the target VLUN;

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updating each log file associated with the identified bitmaps by adding pointers to  
29 the original data located in the target VLUN; and  
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1            updating each associated bitmap to indicate completion of the destage operation  
2 to the target VLUN.

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4        15. (Original) The method of claim 14, further comprising searching the  
5 bitmaps for the presence of original data in the target VLUN, determining the next  
6 available target address for the next destage operation, checking the cache memory to  
7 see if other original dirty data needs to be destaged to the target VLUN and if so,  
8 identifying additional snapshots requiring original data to be destaged and if not, writing  
9 updated bitmaps and log files to the target VLUN.

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11        16. (Currently amended) The method of claim 14, further comprising writing  
12 the log files and the bitmaps to the target VLUN, removing a dirty data designation for  
13 the destaged original data still in the cache memory and sending a destage operation  
14 complete status.

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16        17. (Previously presented) A method of snapshot operation in a data storage  
17 system in a first host that communicates with a cache memory, a source Virtual Logical  
18 Unit Number (VLUN), a target VLUN, first metadata, and second metadata, comprising:  
19            receiving requests from an application to modify data in the cache memory;  
20            writing the modified data to the cache memory;

21            destaging the original data to the target VLUN to preserve the original data of a  
22 first snapshot and a second snapshot; and

23            updating the first and second metadata to locate the original data common to the  
24 first and second snapshot in the target VLUN.

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26        18. (Original) The method of claim 17, further comprising destaging the first  
27 and second metadata to the target VLUN.

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1        19. (Original) The method of claim 17, further comprising updating the first  
2 and second metadata to indicate the presence of the destaged original data in the target  
3 VLUN.

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5        20. (Original) The method of claim 19, further comprising destaging the first  
6 and second metadata to the target VLUN.

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8        21. (Original) The method of claim 17, further comprising destaging the  
9 modified data in the cache memory to the source VLUN to maintain data consistency.

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11        22. (Previously presented) A method of snapshot operation in a data storage  
12 system in a first host that communicates with a cache memory, a source Virtual Logical  
13 Unit Number (VLUN), a target VLUN, a plurality of bitmaps, and a plurality of log files,  
14 comprising:

15            receiving requests from an application to modify data in the cache memory;

16            writing the modified data to the cache memory;

17            destaging the original data to the target VLUN to preserve the original data of a  
18 first snapshot and a second snapshot;

19            adding a pointer in a first log file to locate the original data in the target VLUN;

20            updating a first bitmap to indicate the presence of the destaged original data in  
21 the target VLUN;

22            adding a pointer to the original data in a second log file to locate the original data  
23 in the target VLUN; and

24            updating a second bitmap to indicate the presence of the original data in the  
25 target VLUN.

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27        23. (Original) The method of claim 22, further comprising destaging the  
28 modified data in the cache memory to the source VLUN to maintain consistency.

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30        24. (Original) The method of claim 22, further comprising destaging the first  
and second bitmaps and the first and second log files to the target VLUN.

1        25. (Currently amended) A method of error recovery in a data storage system  
2 wherein a first host verifies that original data has or has not been destaged to a target  
3 Virtual Logical Unity Number (VLUN), comprising: (a) The method of claim 14, wherein  
4 the step of searching the bitmaps to identify snapshots that require the original data to  
5 be destaged occurs after the data storage system fails and includes reading a bitmap,  
6 wherein if the bitmaps contain a value in a bit position [representing] identifying the  
7 original dirty data is dirty in cache memory, destaging the original data to the target  
8 VLUN, and wherein if the bitmap contains an inverse value in the bit position  
9 representing the presence of the original dirty data in the target VLUN, not destaging  
10 the original data.

- 11              (b) ~~removing the dirty data designation for the destaged data; and~~  
12              (c) ~~repeating the steps (a) and (b) until all of the original dirty data is destaged~~

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14        26. (Previously presented) A method of snapshot operation for a data storage  
15 system with a first host that communicates with a cache memory, a source Virtual  
16 Logical Unit Number (VLUN) and a target VLUN, comprising:  
17              generating first metadata to locate first snapshot data and to indicate when the  
18 first snapshot data is in the target VLUN, wherein generating the first metadata includes  
19 generating a first log file pointer to locate first snapshot data in the target VLUN; and

20              generating second metadata to locate second snapshot data and to indicate  
21 when the second snapshot data is in the target VLUN, wherein the first and second  
22 metadata locate the same data in the target VLUN, and wherein generating the first  
23 metadata includes changing a first bitmap to indicate first snapshot data has migrated to  
24 the target VLUN.  
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26        27. (Previously presented) A method of snapshot operation for a data storage  
27 system with a first host that communicates with a cache memory, a source Virtual  
28 Logical Unit Number (VLUN) and a target VLUN, comprising:  
29              generating first metadata to locate first snapshot data and to indicate when the  
30 first snapshot data is in the target VLUN; and

1 generating second metadata to locate second snapshot data and to indicate  
2 when the second snapshot data is in the target VLUN, wherein the first and second  
3 metadata locate the same data in the target VLUN, wherein generating the second  
4 metadata includes generating a second log file pointer to locate second snapshot data  
5 in the target VLUN, and wherein generating the second metadata includes changing a  
6 second bitmap to indicate second snapshot data has migrated to the target VLUN.

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8        28. (Previously presented) A snapshot system for a data storage system  
9 including a first host that communicates with a cache memory, a source Virtual Logical  
10 Unit Number (VLUN), a target VLUN, and metadata, comprising:

11            a source VLUN for active data;

12            a target VLUN to store migrated snapshot data;

13            first metadata to indicate when and to locate where the first snapshot data is in  
14 the target VLUN, wherein the first metadata includes a first bitmap to indicate when the  
15 first snapshot data has migrated to the target VLUN and a first log file to locate the first  
16 snapshot data in the target VLUN; and

17            second metadata to indicate when and to locate where second snapshot data is  
18 in the target VLUN, wherein the first metadata and the second metadata to indicate and  
19 locate the same snapshot data in the target VLUN, and wherein the second metadata  
20 includes a second bitmap to indicate when the second snapshot data has migrated to  
21 the target VLUN and a second log file to locate the second snapshot data in the target  
22 VLUN.

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24        29. (Previously presented) A snapshot system for a data storage system  
25 including a first host that communicates with a cache memory, a source Virtual Logical  
26 Unit Number (VLUN), a target VLUN, and metadata, comprising:

27            a source VLUN for active data;

28            a target VLUN to store migrated snapshot data;

29            first metadata to indicate when and to locate where the first snapshot data is in  
30 the target VLUN; and

1       second metadata to indicate when and to locate where second snapshot data is  
2 in the target VLUN wherein the first metadata and the second metadata to indicate and  
3 locate the same snapshot data in the target VLUN, wherein the first metadata and the  
4 second metadata indicate snapshot data remain in the source VLUN.

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6       30. (Previously presented) A method of snapshot operation in a data storage  
7 system in a first host that communicates with a cache memory, a source Virtual Logical  
8 Unit Number (VLUN), a target VLUN, first metadata, and second metadata, comprising:  
9           receiving requests from an application to modify data in the cache memory;  
10          writing the modified data to the cache memory;  
11          destaging the original data to the target VLUN to preserve the original data of a  
12 first snapshot and a second snapshot;  
13          updating the first and second metadata to locate the original data in the target  
14 VLUN; and  
15          destaging the first and second metadata to the target VLUN.

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17       31. (Previously presented) A method of snapshot operation in a data storage  
18 system in a first host that communicates with a cache memory, a source Virtual Logical  
19 Unit Number (VLUN), a target VLUN, first metadata, and second metadata, comprising:  
20           receiving requests from an application to modify data in the cache memory;  
21          writing the modified data to the cache memory;  
22          destaging the original data to the target VLUN to preserve the original data of a  
23 first snapshot and a second snapshot;  
24          updating the first and second metadata to locate the original data in the target  
25 VLUN;  
26          updating the first and second metadata to indicate the presence of the destaged  
27 original data in the target VLUN; and  
28          destaging the first and second metadata to the target VLUN.

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1       32. (Previously presented) A method of snapshot operation in a data storage  
2 system in a first host that communicates with a cache memory, a source Virtual Logical  
3 Unit Number (VLUN), a target VLUN, first metadata, and second metadata, comprising:  
4           receiving requests from an application to modify data in the cache memory;  
5           writing the modified data to the cache memory;  
6           destaging the original data to the target VLUN to preserve the original data of a  
7 first snapshot and a second snapshot;  
8           updating the first and second metadata to locate the original data in the target  
9 VLUN; and  
10          destaging the modified data in the cache memory to the source VLUN to  
11 maintain data consistency.

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